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THE GREAT SPIRIT SPRING.

By Prof. G. E. Patrick, State University, Lawrence.

The ''Great Spirit'' or ''Waconda'' spring, situated near Cawker City, Mitchell county, Kansas, is a natural curiosity that has excited much interest among both the savage and civilized inhabitants of the State. From time immemorial, this spring has been held in devout reverence by the Indian tribes that but a few years since hunted over middle and western Kansas; and since the advent of the white man, it has become widely known as an object of wonder and speculation among lovers and students of nature.

The spring is distant from Cawker City about two and one-half miles, in a southeasternly direction; is just within the lower bottom of the Solomon river, being perhaps 300 feet from the first terrace, and about sixty rods from the present bed of the river. It flows, not after the manner of most springs, from some hidden nook or cavern, but from the summit of a nearly symmetrical mound, shaped like a low-statured sugar-loaf—or, to be more mathematical, like a truncated cone. This mound is forty-two feet high, nearly as level on the top as a floor; and in the center of this small tableland is found the spring itself, which is quite as remarkable as are its surroundings. Instead of a gurgling rivulet, trickling away among the rocks, the visitor sees before him a smooth, almost motionless body of water, more than fifty feet across, and filling its basin to overflowing—or if not to actual overflowing, so near it that its surface appears to be upon a level with the top of the mound, and in imminent danger of flowing over at any and all points. The only reason why such overflow does not occur is, that the rock forming the mound is very porous, and affords innumerable minute outlets, just equaling in combined capacity the subterranean inlet.

The dimensions of the mound and basin are as follows, from actual measurement: height of mound, 42 feet; diameter at base, 300 feet; diameter at top, 150 feet. The basin, shaped like a funnel—or better, like an inverted cone—is 35 feet deep at the center; its diameter at top, from ''water's edge to water's edge,'' is, N. to S., 52 feet 4 inches; E. to W., 56 feet 8 inches. These figures show the surface of the pool to be very nearly circular. The limestone stratum inclosing it like a ring, of almost uniform width, makes a fine drive-way for carriages, which find an easy ascent at one especially favorable point.

The reverence with which the Indians have always regarded the ''Waconda'' spring, is worthy of notice, as exhibiting in a marked degree some mental traits of a race destined soon to pass away. Upon this subject my knowledge is all at second hand, but I am fortunate in having the following statement from one of the earliest settlers of Mitchell county, now a resident of Cawker City, a man whose character vouches for the truth of his words. In response to a request from me, he writes: ''In answer will say, that through Indian interpreters I have the statement from various tribes visiting our spring, that Waconda, the daughter of a great Indian chief, at one time became infatuated with the son of another. The two tribes met at the spring, and being hostile to each other, the intimacy was strongly opposed by the parents, and a conflict ensued. The lover of Waconda, being wounded and weak from loss of blood, fell or was hurled into the pool, whereupon Waconda plunged in after him, and both were drowned. Ever since the spring has been called ‘Waconda,’ or the ‘Great Spirit’ spring, and the Indians believe that the spirit of Waconda still dwells in the mound, and sometimes becomes offended at bad Indians, and throws up vast volumes of water, drowning them. The Pottawatomies, who have often been through here on their hunts since this country was settled, could never be prevailed upon to pass the spring without stopping to have a regular pow-wow, and dip their arrows into its waters. They believed this would give them great success in their hunts and wars with other tribes. Every tribe that has ever visited this country since its earliest settlement, has shown the greatest reverence for the spring, never failing to visit it, and always going through a ceremony over its waters. On one occasion we invited 300 Indians, who were on a buffalo hunt, and were encamped near the spring, to come up to Cawker City and give us a war dance. They accepted, but on no condition would they come until they had been to the spring and daubed their faces and ponies with the gray mud from its banks, and when they came, their appearance in the light of the bonfires built for the occasion was frightful in the extreme.”

From the same gentleman, as well as from others, I learn that many relics have been “fished” from the pool, including bows and arrows, a bent rifle or two, arrow-heads, colored stones, medals and beads, (one medal bearing the stamp, “The Fur Company of 1844,” and the figures of a white man and an Indian making friends over a pipe of peace,) articles thrown in probably to propitiate the Great Spirit.

It is asserted by many who have made frequent use of the waters of this spring, that they possess valuable medical qualities; and as they have acquired more than a local reputation, I have deemed it worth the while to visit the spring, collect samples of the water, and submit the same to thorough chemical analysis. The following are the results, each figure being the mean of at least two closely-accordant determinations:

Specific gravity at 60° Fah., 1.017.	Grains to U. S. gallon.
Sodium chloride	775.703
Sodium bromide	.234
Sodium sulphate*	206.357
Magnesium sulphate	66.050
Magnesium carbonate	41.023
Calcium carbonate	31.398
Silica (probably combined with soda)	Traces.
Nitrous acid	Minute trace.
Organic matter	None.
Total solids, upon evaporation	1120.765

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*In a private report, made some time since, a small amount of the sodium was stated as bicarbonate, and an equivalent amount of magnesium as sulphate. This is probably the more accurate form of statement, as indicated by the CO2 determination and by the alkalinity after long boiling; but the above is in accordance with the mode of statement now adopted by many chemists, and is in some respects preferable.

Carbonic acid gas evolved upon boiling, 91 cubic inches to the gallon U. S.

From this analysis it is seen that the water of this spring bears a general resemblance to several other waters of the State that have been anaylzed, among them that of the Iola gas well, my report upon which was published in the proceedings of this Academy for 1876—the general resemblance consisting in the presence of a large amount of sodium chloride, considerable quantities of the salts of magnesium or calcium, or both, (besides the carbonates of those metals,) and, usually, some sodium sulphate.

While there is this resemblance, the water of the Great Spirit spring differs from all those hitherto examined, in the great amount of sodium sulphate which it contains. In it the sulphates (of sodium and magnesium) constitute over 24 per cent of the total solids, while in the Iola water they are but a mere trace—little more than .1 per cent. Curiously enough, the two waters (Great Spirit and Iola) contain the same very small amount of bromide (probably of sodium), namely, .234 grain to the gallon. But in respect to iron they differ again, the Iola giving 1.343 grains of ferrous carbonate to the gallond, the Great Spirit containing not a trace.

The most peculiar feature about the spring is the mound, from the top of which it issues. All the reports I have seen—and several have been published in various newspapers—assert that the mound has been built up by the gradual deposition of the saline ingredients of the water; and I visited the spot fully expecting to find a mound composed of sulphates and carbonates of calcium and magnesium, arranged in concentric layers conforming to the outline of the mound, as would be the case had the water of the spring been the architect. But instead of any such arrangement I found the mound to be composed of horizontal strata of limestone, broken off sharply at the edges, where sections of many feet in thickness are exposed. This limestone surprised me by its extreme hardness, which was from four to five, and in some places seemed to me to exceed the latter figure; indeed, so remarkable was it in this respect, that I could hardly believe it to be a mere limestone until I had applied a chemical test. Although it is a limestone, it is not an ordinary one, as is evident from its physical appearance. It is exceedingly porous and unhomogeneous, showing everywhere the results of chemical change effected by some ingredient of the spring-water. That this change has consisted largely in the formation of a hard, insoluble silicate, by metathetical reaction between the sodium silicate of the water and the carbonate of the limestone (or possibly of the water itself), is evident from the physical appearance of the rock. The portions showing the greatest porosity are the hardest, and in the larger cavities a hard layer of silicate can be distinctly seen and easily identified as such.

Although the silica of the water is in so small quantity as to be reported as "traces," I think it perfectly competent to have effected this change, considering the long time it has had for its work. Morevoer, it is the only conceivable agent, under the circumstances.

Being curious to learn what changes, if any, had taken place in the bases of the original limestone, I selected a piece in which silicification had occurred but moderately, and submitted it to analysis, after having removed by washing all the soluble salts deposited in its pores, with the following result:

Lime, CaO	52.99	per cent.
Magnesia, MgO	1.32	per cent.
Ferrous oxide, FeO	1.07	per cent.
Carbonic oxide, CO_2	42.59	per cent.
Silica, SiO_2	2.03	per cent.
	100.00	

As dilute chlorhydric acid extracts a large part, if not all, of the ferrous salt, and as the hardness of the silicate observed in the rock is greater than that of ordinary hydrated magnesium silicate, I conclude that probably the magnesium and iron are mainly in the form of carbonates, and that the silica is combined chiefly with lime, thus:

Calcium carbonate, $CaCO_3$	92.02	per cent.
Magnesium carbonate, $MgCO_3$	2.77	per cent.
Ferrous carbonate, $FeCO_3$	1.72	per cent.
Calcium silicate, (and silica?)		
CaO	1.46	per cent.
SiO_2	2.03	per cent.
	100.00	

In this specimen the silification had not been great. I presume specimens could be found showing two or three times as much silicate; and it must be borne in mind that silicate formed in the pores of a limestone by infiltration and double decomposition, would have many times the hardening and cementing power of the same amount of silicate mechanically mixed with the limestone ingredients at the time of deposition—a fact illustrated and applied in the manufacture of the Ransom artificial stone. The small amount of magnesium carbonate hardly indicates metamorphosis, as nearly all limestones contain as much. Indeed, in view of Dr. T. S. Hunt's researches, (Chem. and Geolog. Essays, 2d ed., pp. 138 and 86,) we should not expect a reaction to occur between a limestone and magnesium salts in solution. As the spring water contains no iron whatever, the ferrous carbonate was probably an original constituent of the stone.

The only metamorphosis, then, indicated by this analysis, is that resulting in the formation of three to four per cent of silicate of lime—a small amount comparatively, but sufficient to impart to the stone a hardness plainly superior to that of ordinary limestone.

In conclusion, my explanation for the existence of the mound is, briefly, that the limestone strata constituting the present mound were once continuous across the Solomon valley, and formed the bed of that river; that the Great Spirit spring, then entirely submerged, added its mite upward through the river bottom to the mighty flood above; that the alkaline silicate of the spring water gradually effected the partial silicification of the limestone bed in all directions, within a certain radius, so hardening and cementing that portion as to enable it to withstand the eroding action of the river, when, having subsided to the limits of the "lower bottom," it disintegrated and washed away the unchanged limestone, leaving the preserved portion (upon the further subsidence of the waters to their present bed) no longer an islet, but a mound upon dry land—a monument to the power of the chemical agencies at work in nature's laboratory.

SINK-HOLES IN WABAUNSEE COUNTY.

By Joseph Savage.

While on a visit to Wabaunsee county during the summer of 1879, my attention was directed to a series of sink-holes which occur near the southern line of the county, some four or five miles northwest of Washara post-office. These sink-holes occupy a space of about four miles in extent from east to west, and a much narrower limit from north to south. They occur upon high prairie, the highest; in fact, in all that region. The surface upon which the sink-holes are situated is quite level, and would make good arable land for cultivation. The sink-holes pass through two rock formations, both of impure limestone. The uppermost formation is about two feet in thickness, while the lower one is four or five feet thick and fifteen or twenty feet below the surface. The sinks pass through both of these strata and the intervening clays, and the subterranean caverns are found below the lower rock formation.

At my request, these sink-holes have been partially explored during the past summer by Mr. S. N. Hills and my brother, Mr. F. Savage. They found the passage-way partially choked up with loose stones, but when fairly down they found a series of caverns of considerable dimensions. The caves were ornamented with numerous stalactites and stalagmites, and one little grotto of columnar structure was so finely scalloped and finished, as to almost if not quite excel in beauty of finish any statuary work of man's device. The apparent beauty of this little grotto was no doubt much enhanced by the dim lantern-light, as well as by the mineral waters constantly dripping over its outer surface. Quite a quantity of loose bones were found in these caverns, showing that they were the frequent habitation of wolves and other wild animals.

The cause of these sink-holes seems to have been in the loose, friable nature of the rock formation which surrounds them, and their surface indications are shown by depressions from forty to eighty feet in diameter; hence, as will be readily seen, the water during heavy rains concentrated and ran into them, causing wet-weather springs along the adjoining drains and ravines.

In a State so richly endowed as we are with thick beds of limestone, one would naturally expect to find numerous sink-holes and openings along our high prairie lands. These openings have been observed in a small way